Geographic information coordination in the states

Lisa Warnecke

Geographic information represents an opportunity and a process for states to develop a resource to improve public effectiveness. State governments are in a key role to develop this resource through partnerships among the public, private, and academic sectors.

Inf Manage Review, 1988, 3(4), 27–38
© 1988 Aspen Publishers, Inc.

Governments are increasingly faced with multidimensional and multijurisdictional issues and decisions, often with reduced time frames and financial resources and greater impacts and complexity. Public decision makers often do not have information available or in the proper format for their needs. They are also experiencing greater expectations for services, efficiency, accountability, and fiscal responsibility.

Improved effectiveness of information resources can assist in addressing these needs. Government has a unique role as primary creator, disseminator, user, analyzer, and regulator of information, with a social responsibility to the public. Management of government requires effective management of information. Use of information technology (IT) has often been developed, funded, and initiated by government. With over 80,000 units of government in this country, the United States has the most extensive information resources and technologies in the world.

There is unprecedented growth in the development and use of IT, but it has often resulted in increasing fragmentation and incompatibility of information for multifunctional purposes. At the same time, single-purpose legal directives and reporting requirements increase while records-management methods often grow out of date. Despite declining computer costs, information costs have been increasing in the federal,[1] state,[2,3] and local governments.[4] It is predicted that information technology could be "one of the most expensive innovations ever adopted."[5]

GEOGRAPHIC INFORMATION OPPORTUNITIES

A broad focus on geographic information (GI) is suggested as a conceptual basis and framework from

Lisa Warnecke, M.B.A., *is the Director of Research and Development for the School of Information Studies at Syracuse University. She previously has served the states of Colorado and Wyoming as a Geographic Information Coordinator and a Budget Analyst, respectively. She has also been a Town Manager and a Consultant in Colorado.*

This article is reprinted with permission from Allison, L.J., and Olson, R.J. (eds). "Geographic Information Coordination in the States: Past Efforts, Lessons Learned, and Future Opportunities." Paper presented at conference, Piecing the Puzzle Together: A Conference on Integrating Data for Decision-making (CONF-87-5147), Washington, D.C., 27–29 May 1987.

which to disaggregate, integrate, access, and display information. Well over one-half of all public information can be referenced by location, including natural resources; infrastructure; land use; demography; land tenure; and geographic, legal, and geodetic references. It is developed and used by virtually all public agencies, academia, and many diverse private sector interests, thus providing a link between these entities. Technologies and tools, such as satellite imagery, satellite surveying through Global Positioning Systems' receivers, and Geographic Information Systems (GISs) are improving the accuracy, management, and usefulness of GI. A broad focus can maximize not only these GI-related technological improvements but also more general ones, such as database management systems, telecommunications, distributed systems, office automation, artificial intelligence, and real-time systems.

An emerging national challenge is to address the above trends and improve the effectiveness of our governments, IT investments, and international competitiveness. Maintaining our knowledge base is critical in these efforts. Conceptually, a horizontally and vertically integrated, multipurpose GI network would provide a focus, process, and an information resource for many national, state, and local issues and needs. Accordingly, state and local information resources and public investments at all levels would be a foundation for national use. In turn, referencing national information by location would reduce it to the lowest common denominator for maximum use by other governments, businesses, academia, and the public.

Many countries are developing broad focuses and systems with which to manage their GI resources.[6,7] They also often have greater levels and longer histories of cooperation in the development of information systems.[8] In addition, the adoption of national systems is often facilitated by the centralized governmental structures more evident in other countries than the United States. Coordination of GI among countries is also emerging. For example, the Council of Ministers of the European Community established a Coordinated Information on the European Environment Program in 1985 to provide environmental information in a form for policy-making uses.[9] A GI framework and GIS are being used to meet this goal.

This comparative disadvantage and the increasingly decentralized form of government may restrict the nation's ability to prepare for the future, compete globally, improve public effectiveness, and maximize technological capabilities. Instead, the United States has an opportunity. Considering the great variety and volume of information and emerging technologies, an information network is appropriate. However, a network requires more coordination of policies, institutional innovation, standards, procedures, and knowledge of user functions and needs than does a centralized system.[10] Conceptualizing and implementing a GI network will help accomplish various informational needs with shared resources, but it will also establish a focus and process for entities to work together for common goals.

INCREASING ROLE OF THE STATES

The importance of state governments is increasing in many areas. With central placement between the federal and local governments, states are in a key role to develop and effectuate GI networks. Local governments, including counties, municipalities, and special districts, have primary responsibility for detailed land information, but their authority, organization, and abilities are defined by state directives. States are also in a key role to provide local governments with direction, incentives, and assistance, while ensuring compatibility and usefulness for state purposes. Unfortunately, state statutory directives have been limited for multipurpose information resources and have often contributed to the fragmented and incompatible nature of land recordation in this country.[11]

Federal directives, regulations, and funding sources have been responsible for the development of much GI. However, declining financial support and delegation of responsibilities—coupled with the comparatively better financial health, increasing activism, and applicable statutory capabilities that states have—create a growing role, responsibility, and opportunity for state governments.

USE OF TECHNOLOGY

States have utilized IT for many aspects of GI in state government. Inventories and analyses have been con-

ducted in general and regarding two functional areas, natural resources and infrastructure, with similar conclusions. These analyses reveal an increased adoption of IT, but often with decentralized, fragmented, and incompatible systems.[12,13,14] GI technologies have also been used in the socioeconomic area, largely based on U.S. Bureau of the Census data with various modeling tools. In addition, they have been used for support functions by defining boundaries for generating and distributing funds.

Natural Resource Information Systems

Natural Resource Information Systems (NRISs) began in the 1960s, with the greatest growth in the 1970s, in response to environmental concerns, legislation, IT, and remote sensing capabilities. Up to 32 state initiatives have been identified, with a wide diversity of systems and strengths (Table 1).[15,16] Five states have discontinued systems as of 1982 because of funding or political constraints, while others experienced differing levels of success.[17] More recently, over 300 different state natural resources databases were identified in addition to NRIS initiatives.[18] In contrast to these systems are standardized Natural Area Data Centers established in 46 states by the Nature Conservancy.

Infrastructure systems

An analysis of infrastructure information systems in 1982 identified over 500 systems in state agencies with "an unusually high number of unique systems suggesting there may be little commonality . . . between the states."[19] Reviews of transportation systems have concentrated on computer-aided design (CAD) systems. Conducted by various Departments of Transportation, including Iowa, Arizona, South Carolina, and Washington, these reviews revealed that almost all states are using or plan to use such systems for automated design, with some evolving into broader information management systems.

Geographic information systems

GISs have been identified in 35 state governments, with virtually all states having some activity in one or more local governments, federal agencies, academic institutions, or businesses. Primary collection of this information was difficult, and identification of initiatives, rather than a thorough analysis of systems, had to suffice. Some noteworthy systems are described in the case examples. Most GIS developments are in natural resource functions, with 12 states having other functions such as planning, transportation, local affairs, public lands management, and property assessment.

Geographic information systems have been identified in 35 state governments, with virtually all states having some activity in one or more local governments, federal agencies, academic institutions, or businesses.

DATA CENTERS, LEAD ROLES, AND STANDARDIZATION

One or more GI-related data centers have been identified in each state. Some have designated lead agencies or coordination staffs. Most have required or recommended some form of standardization of their local governments.

Data centers

All states have initiated at least one form of data center to access some geographically referenced information. Only a few, however, have developed interagency, multipurpose state information centers. As with information systems, data centers are often located by their specific functionality rather than as part of a multipurpose information resource.

As of 1985, all states have agreements with the U.S. Bureau of the Census for at least one Census Data Center. Between 1976 and 1987, 48 states (except South Dakota and Colorado), established agreements with the U.S. Geological Survey (USGS) to serve as National Cartographic Information Center (NCIC) affiliates to access and distribute USGS products. A few years ago, an Earth Science Data Directory was initiated by USGS and now includes input and access by 40 states. Analysis of the effectiveness of these

Table 1

GEOGRAPHIC INFORMATION IN THE STATES

	NRIS[1]	GIS[2]	NCIC[3]	Lead agency[4]	Parcel map & ID[5]	Ownership data[6]	Coordination staff[7]	Names board[8]	SMAC[9]	Other[10]
Alabama	N	C	G	T	*2	L	PS	1G	3G	
Alaska	N	N	U				A,S	2A	I	
Arizona	N	N,L	N	T	*5	L	A,PG	1L	1V	
Arkansas			G		2	M	S			
California	I	N,L	U	N	*6		O	3L	2N	G,L
Colorado		C,N,T			*2	H		4R		O
Connecticut		N,N	N,U			L		2G		
Delaware			N	T					1G	
Florida		PL	U		*	L	A,S,C	5O		
Georgia	N		F		*6	H	S	R		L
Hawaii	N		A,U		*5		S,C	2N	1V	L
Idaho			H	G	*1		A,C	2H	1L	G
Illinois	N	N	G,U		*2	L	O	U	4V	G
Indiana		PN	U		*2					
Iowa	N		G		*	L			4G	
Kansas		N	P		*1	H	C	P	V	G,O
Kentucky	N	N	G		*6	L		U		
Louisiana	N		T		2		A	U		
Maine		N	G,U			M		1G	1G	G
Maryland	N	A	G	G	*5	H	A		3G	
Massachusetts		N	U		*6	M	A			G,L
Michigan	N	N	N	N	*2			1G	3G	G
Minnesota	N	N,A	A		2	H	A,O	2N		
Mississippi	N	A	N		*6		A		V	G
Missouri		PN	G	G	*2		S		4N	G
Montana	N	PN	U		3	M	A	1N	1G	O
Nebraska	N	N	N		*2	H	A,S	4H		
Nevada			G		*5		C	2E	1G	
New Hampshire		A	U			M	A	5A		
New Jersey	N	N,T	N	N,T	*5	M	PA		1N	G
New Mexico	N	U	U		*1,3		PA	U	1U	G,O
New York	I	N,N,O	T		*3,5	H	PA	2H		G
North Carolina	N	N	G	N	*4		S		4N	G,L
North Dakota	I	O	N			L				
Ohio	N		N			H	A			
Oklahoma			P		2	L		2G		
Oregon		N,T	R,U		*1	L	A,C	1H	1G	L,O
Pennsylvania			G		*	L	A	2H		
Rhode Island		N,A	U			H	A	4A		
South Carolina	N		N	A	*6	H	A,S	4H	1A	G,L
South Dakota	I				*2	H	A			
Tennessee		N,U	G		*3,5	L				G
Texas	N	N,T	N	N	*			2L	4N	G
Utah	N	N,A	G		*		C	1H	2G	G
Vermont	I	U	U	O	6	L	PA	2R	1V	G
Virginia	N		N		4,6	L	PA,O	1R,T		L,O
Washington		N,T	R	N	*2	L	A,S,C	2N	2N	G
West Virginia			G		*5	L				
Wisconsin		N	N		2	H	A,C	2N	2A	G,L
Wyoming		N	N		2	L		1N	I	

federally affiliated information dissemination centers is beyond the scope of this article, but it will be addressed in an upcoming study by the U.S. Congress' Office of Technology Assessment.

Some states have established natural resources data centers in conjunction with their NRIS. Minnesota, Hawaii, and Texas are the only states with their Census Data Center, NCIC, and NRIS in the same agency.

Table 1 *continued*

Use of technology: Systems

[1]Natural Resource Information Systems (NRIS)
Location: N = Natural resources agency
I = Inactive

[2]Geographic Information Systems (GIS)
Location:
A = Administration/planning
C = Community/local affairs
G = Geological survey
H = Historical society
I = Inactive
L = State/public lands
N = Other natural resources
O = Other
R = Archives/libraries
T = Transportation
V = Varies

Centers, leads, and standards
[3]National Cartographic Information Center affiliates (NCIC)
Location: See GIS[2]
U = Academic institution

[4]Lead mapping agency
Location: See GIS[2]

[5]Parcel maps and identification systems

	Required	Recommended
Public land survey system	1	2
State plan coordinates	3	4
Map, block, lot format	5	6

*State requires ownership map

[6]Quality of ownership transfer data
H = high, M = medium, L = low

Coordination Staffs and Groups
[7]Geographic information coordination staffs
A = Geodetic advisor
C = Cartographer
G = Geographer
O = Coordinator/other
P = Pending
S = Surveyor

[8]Geographic Names Board
Location: See NCIC[3]
Directive: 1 = Executive order
2 = Specific legislation
3 = Agency authority
4 = Informal
5 = Other

[9]State Mapping Advisory Committee (SMAC)
Location: See NCIC[3]
Directive: See geographic names board[8]

[10]Other
G = GIS user's group
L = Land Records Reform Initiative
O = Other interagency groups: Kansas Commission on Applied Remote Sensing, Montana Resource Data System Advisory Committee, New Mexico Geographic Information Council, Oregon Map Advisory Council

Lead roles and standardization

Approximately one-third of the states have identified a base mapping program and state agency with a lead role.[20] Though usually part of a natural resources function, such as land resources, geology, water, or transportation, arrangements vary considerably. Some states have base mapping standards or formats to enable an exchange of digital data between agencies. These efforts are most often accomplished

through an interagency State Mapping Advisory Committee (SMAC), but sometimes are located in one office, such as California's Map Information Office, Utah's Automated Geographic Reference, and Missouri's Geographic Resources Center.

Parcel level property ownership maps and information are often required by states to support property tax assessment and ensure equalization. Two-thirds require property ownership maps, and 37 states require or recommend parcel identification systems. Most states solely use legal reference systems such as the Public Land Survey System or the map, block, and lot format. Six states use State Plane Coordinates as a geographic reference, most often in conjunction with one of the other systems.[21] A related study conducted to evaluate rural land transfer record systems identified and rated 35 states that collected parcel level transfer documents at the state level.[22]

RESOURCE COMMITMENTS

All states have numerous financial and personnel resources committed to information in general as well as to functional aspects of GI.

Financial

Analyses are limited, but noteworthy studies were conducted in South Carolina and Wisconsin. In the former, an annual expense of over $277 million was identified for IT in 1985.[23] In Wisconsin, expenditures by all levels of government and utilities for land information alone were almost $79 million in 1976, or over $135 million in 1987 dollars.[24]

State financial commitments are difficult to ascertain for GI resources because financial systems often do not enable such analysis. Sometimes, one agency serves as such a resource as part of its overall mission and, in others, a multiagency effort does not adequately reflect costs. Minnesota and Illinois are considered to have the largest measurable financial commitments, with annual budgets of $1.3 and $1.1 million respectively, including support from user charges.

Personnel

Many states have functionally specific and generalist positions to help coordinate information. Generalist positions are difficult to classify and analyze. State staff contacts are designated for the Census Data Centers and NCICs, with some states having official state demographers as the contact for socioeconomic information. Other functional designees often include state geologists, foresters, climatologists, archaeologists, and historic preservation officers, with state librarians, archivists, and historians responsible for more general information.

Regarding GI specifically, nine state surveyor positions were created in the early 1970s. Their number may not grow because 20 state geodetic advisor positions have been established, with half of their funding from the National Geodetic Survey. Over one-half of the state geodetic advisors have been appointed since 1985 (the program was initiated in 1974), and six more are pending. Nine state cartographer positions were developed in the 1980s, some with USGS funding. In some states, such as Hawaii, Florida, Kansas, and Arizona, state geographers are being considered, or the role of state cartographer has been or may be expanded to that of state geographer. Also, general coordinator positions exist in California and Virginia.

Some states, such as Minnesota, Illinois, Texas, and North Carolina, have exemplary GI centers or systems, but they have not designated their staffs by names that would facilitate categorization. Minnesota has probably the largest staff, with 40 full-time equivalent positions at its Land Management Information Center.

GI COORDINATION GROUPS AND DIRECTIVES

State GI coordination groups have existed throughout this century to reflect relevant needs and issues of the time. Each state has addressed conditions differently, though some common themes and issues prevail. Enabling directives and locations of activities vary considerably, but success is often most dependent on awareness, commitment, and leadership of initiators of these efforts.

Geographic Names Authorities

The first interagency groups to address GI were Geographic Names Authorities. Established as affiliates of the U.S. Board of Geographic Names, they

provide for accurate and standard name usage. The first state authority was in Oregon in 1907, and 33 active affiliations exist today with various locations, directives, and levels of activity.[25]

State Mapping Advisory Committees

A second wave of GI coordination efforts began in the 1940s to identify mapping priorities and later resulted in the development of SMACs. Usually authorized by legislation or executive order, SMACs were encouraged by USGS to represent the needs of all map users in a state and often participated in joint mapping projects. Currently, 26 SMACs are considered active, with varying locations, funding, activities, and successes. A recent survey revealed needs for stronger commitment, with over 25 percent rating their SMACs as ineffective.[26] More successful SMACs are broadening their scope in GI.

GIS user groups

Recently, GIS user groups have emerged informally and have been identified in 19 states, with six as subcommittees of their SMACs. This technology often served to integrate natural resources data and is now expanding to other functions. These groups are facilitating sharing of digital data and the development of standards and cooperative projects among agencies and other users. Although most groups are informally organized, a GIS Task Force was created by the Hawaiian Legislature in 1987.

Land-records reform initiatives

Another focus of GI coordination efforts is the growing need for land-records modernization at all levels of government. These reform initiatives address the fact that parcel-level data are maintained by various government offices, often with incompatible, fragmented, and redundant GI. An integrated, accurate land-records system, or multipurpose cadastre or land-information system is advocated, with all forms of GI and a geodetic reference base.[27] Many of the commonly advocated reforms must be authorized by state directives; thus, initiatives are growing at state levels. These land-records reform initiatives have a long history, but need is increasing because efficient management of information is necessary to maximize the usefulness of GI technologies. Interest has grown recently, with identified activities in eight states and legislative action in Georgia and Virginia in 1987.

Geographic Information Councils

Some states with one or more of the above groups are experiencing ineffectiveness or conflict among efforts. Broad-based, or "umbrella," GI coordination groups, such as GI Councils, are emerging to address all of the above issues from a global focus—sometimes with representation by all levels of government, academia, and the private sector. The governors of New Mexico and Oregon have addressed GI from this perspective and signed executive orders in 1987 to establish such groups. Their focuses, directives, and emerging frameworks are appropriate models for others.

Broad-based, or "umbrella," groups such as geographic information councils—sometimes with representation by all levels of government, academia, and the private sector—are emerging to address issues from a global focus.

CASE EXAMPLES

States have addressed similar GI issues and needs in differing ways. No one method is a recipe for success, but knowledge of differing approaches can help in establishing initiatives and broadening focuses. In the evolution of GI development, usage, and coordination, some exemplary examples can be identified and categorized by focus, partnership, or directive.

Singular agency focus

Most states' use of GI technologies has been in the natural resources area, as represented by the growth of NRISs in the 1970s. As a result, when lead agencies have been designated or assumed, most have been located in this area. Recent infrastructure mainte-

nance and management requirements, economic development efforts, and traditional mapping responsibilities—combined with comparatively fewer financial resources for environmental management—have resulted in incentives for transportation applications of GI technologies and potential lead roles. Regardless of the function of lead agencies, many states are increasingly developing interagency efforts to maximize capabilities.

Natural resources: Texas and Illinois

The Texas NRIS, initiated in 1974, was once considered one of the most extensive systems in the country. It grew from the water resources area, with 13 agencies coordinating their clearinghouse and network of information functions. Current technological adoption has been constrained by financial limitations.

More recently, Illinois developed a GIS in 1983. The system was largely financed by federal funds initially used to evaluate coal suitability within the state. Since its development as a state information resource, it has been applied to a variety of integrating data applications, such as economic development. It is one of the most extensive systems in the country.

Public lands management: Arizona

Public lands management is a unique focus of GIS, as utilized by the Arizona Land Resource Information System. It was developed by legislative authority in 1982 to effectively manage Arizona's state-owned land. With many efforts, systems, and an SMAC, this agency was designated with a broadened mission for statewide GI coordination.

Parcel mapping/assessment: New York

New York's Real Property Information System is the only state-run program using GIS for assessment purposes, though many local governments are using this technology to manage their parcel-based GI. Initiated in 1983, the system helps ensure that assessments are computed correctly and that appraised values correspond with actual land values. It has been found useful for inventorying sales; selecting types by class, size, and age; and in developing a link with the state's railroad network, census data, and various jurisdictions. It also has cultural uses. New York has other GIS initiatives and is developing a statewide focus with a state GIS users group.

Transportation and demographics: Colorado

Colorado is the only state with GIS capabilities in transportation and demographic functions. These systems were purchased in 1986 and 1980 respectively. Additionally, an NRIS was initiated in 1974, and public health applications of GI technologies have recently emerged. A governor's forum on geographic information was recently held, and some coordination efforts are underway.

Statewide focus

Many single-agency focus states, as described above, are realizing and effectuating interagency coordination and jointly developing GI resources and systems. Others have evolved from a statewide focus.

Minnesota

Minnesota's Land Management Information Center is often considered one of the most mature and successful systems in the nation. Developed 20 years ago at the University of Minnesota under contract with the state, it was transferred to the State Planning Agency in 1977. The center is a resource and neutral location for both state regulators and applicants to access GI. It serves as a clearinghouse and service bureau, with 60 percent of its projects funded by user fees. Two-thirds of these fees are paid by state agencies, with one-quarter of their clients representing the private sector.

Utah

An emerging GI coordination effort is in Utah's Executive Department, which serves as the State's GIS implementation authority. Their Automated Geographic Reference is used for a variety of projects. Networking capabilities are being developed between agencies, as in Minnesota.

Interorganizational partnerships

Interorganizational partnerships have emerged as valuable frameworks and methodologies to under-

stand the needs of differing organizations and to share resources with reduced time frames and expense. Each of the following examples serves as pioneers in this regard. Collaborative development efforts among municipalities, counties, and utilities—such as in San Diego, California; Indianapolis, Indiana; and Nashville, Tennessee—and with the private sector—as in Boise, Idaho—also serve as excellent models. However, more and expanded cooperative development efforts are needed to meet growing financial limitations and information needs.

Local government: North Carolina

North Carolina has an exemplary partnership with local government in its land-records management program. This program provides a matching grant program to help counties develop maps to meet state standards. Funds are used to develop base maps, property maps, standard parcel identification systems, historic records systems, and standard automated record keeping processes, designed by state departments. It is being considered as a model by other states.

Federal government: Connecticut

Connecticut jointly developed a GIS pilot project with the USGS in 1984 to integrate various data sources for a selected area within the state. The system was used to develop ground-water and industrial-siting analyses. The project became a model for other USGS cooperative projects.

Academia: Wisconsin, Kansas, and Ohio

Many state governments work with academic institutions in their states. One of the most well-known relationships is between the state and the University of Wisconsin. The most comprehensive analyses of geographic information from a land records perspective have been conducted by the University. Largely through the University's help, the Wisconsin Land Records Committee was established by executive order in 1985. The Committee analyzed various aspects of GI and recommended the creation of a State Office of Land Information and affiliate offices in county governments.

Kansas has had a Commission on Applied Remote Sensing since 1983, with representation by state agencies and staffing by the University of Kansas. Their efforts have included the use of various GI technologies for state needs and the development of an expanded focus and analyses with legislative support. Recently, an interuniversity consortium, the Center for Advanced Land Management Information Technologies, has emerged, comprising four institutions located in Kansas and Nebraska.

Another example of cooperation is emerging between Ohio and the Ohio State University. The University's Center of Mapping is assisting Ohio's state government in its natural resources and GI coordination efforts and development.

Directives

While informal cooperative efforts have experienced some measure of success, directives are increasingly recognized as needed for institutional modernization and for providing state leadership, authority, incentives, standards, and financial resources. They are also necessary to ensure interagency coordination and the design of statewide, multipurpose information resources rather than single-purpose systems.

Executive order: New Mexico and Oregon

New Mexico is the first state to have its official directive and coordinating group include all of the coordination focuses discussed in this article. Under the leadership of the Technology Application Center of the University of New Mexico, an executive order established New Mexico's GI Council in 1987.

Oregon was faced with the existence of two strong coordination groups, a SMAC and a land records reform initiative. It is the first state to officially address

New Mexico is the first state to have its official policy directive and coordinating group include all of the four identified geographic information focuses.

this situation, and the governor's office arranged a merger of the two groups, with a broad-based perspective, in a 1987 executive order.

Legislative authority: Virginia, Montana, Georgia, and Hawaii

After having a legislative analysis conducted in 1986, Virginia's state legislature authorized during its 1987 session both a new Division of Mapping, Surveying, and Land Information Systems and a state coordinator. This office was established through extensive efforts of various entities in the state.

During its 1985 session, Montana's legislature approved the development of an NRIS and broad-based interagency advisory committee, uniquely located in and directed by the Montana State Library, with guidance from the governor's office. This location was chosen as a neutral and traditional information management and dissemination location.

Legislative studies were authorized in 1987 in Georgia and Hawaii. Georgia's initiative created a Land Information Systems Joint Study Committee that has both interagency and intergovernmental representation. Hawaii's State Legislature established a GIS Task Force, made up of members from the public and private sectors, with the objective of recommending a GIS for the state.

CONCLUSIONS

This article presents a framework for addressing GI in the states from a policy perspective. This inventory of available information was compiled to classify, analyze, and identify needs and areas for further research. The article also details the need for and usefulness of more thorough inventories and analyses. By understanding both the efforts of individual states and existing trends, states can develop improved methodologies to address and maximize their GI resources and investments.

Analyses

Analyses reveal that the proliferation of IT in the public sector will continue, but with a continued gap of ten to 15 years between the development and widespread use of the technology.[28] Resource commitments and costs will increase, along with the difficulty in using derived information for executive-level decision making. This gap, system fragmentation, incompatibility, and redundancy will prevail because of existing legal directives, funding mechanisms, recording methods, and the decentralized structure and complexity of government. Improving and integrating technologies will become more institutionalized, with networked resources sometimes replacing central data depositories. However, recent research suggests—and the conclusion is increasingly supported—that "organizational context will be more influential than technological infrastructure in determining the growth and use of computing in organizations."[29]

Institutional arrangements

Institutional arrangements are even more crucial in regard to GI because interorganizational coordination is essential to maximize its usefulness. In general, existing trends and gaps are expected to continue because organizational change traditionally occurs much more slowly than technological development.

GI is an underdeveloped resource and conceptual basis to disaggregate, integrate, access, and display differing kinds of information from various sources, while reducing fragmentation, incompatibility, and redundancy. GI technologies, accuracies, and applications in infrastructure management will grow significantly, especially in utilities. Usage in natural resources and social sciences and the integration of various data and sources for additional applications will also increase. Real-time uses will emerge, but lack of and cost of quality data in appropriate and accessible forms will limit applications. As concluded by a 1987 British governmental report, maximization of GI technologies is limited by the "great diversity of users and uses [and] the human and organizational problems of achieving change. . . . [further] many users and potential users are not sufficiently aware of the benefits of GIS [and] the fact that GIS are only tools, albeit essential ones, for better decision making."[30]

Governmental, and particularly state, roles are generally increasing in regard to information resources management and in GI, with differing approaches and levels of success. Related technologies have been

applied in states for over 20 years; coordination efforts date back 80 years; and land recording methods are older than the country. However, widespread adoption and focus on this area has only occurred recently. An exponential growth in automation during this decade is being followed by a greater rate of growth and an expanded focus of state coordination initiatives and directives over the last few years. In 1987 alone, six official directives were adopted, including the first two states' (New Mexico and Oregon) adoption of broad directives with all four coordination focuses discussed in this paper.

PREPARING FOR THE FUTURE

Government's unique role will increase in the "information age." Vision, commitment, leadership, and innovation are needed by decision makers to develop appropriate role definitions, proactive information policies and directives, modernized institutional frameworks, interorganizational partnerships, financial support, data resources, and implementation strategies. These factors are often cited as crucial for the successful adoption of change.

Newly forming broad GI groups; other state information entities responsible for data processing, libraries, archives, and records management; and emerging information policy groups need to develop merged focuses on public information policy and conceptual frameworks and mechanisms to link information, such as GI networks. Merged focuses should eventually occur, as governments evolve from concentrations on IT and systems to development of information as a strategic resource.

Capitalization and compatibility of our information resources are essential. Data development can represent as much as 90 percent of the cost of implementing GI resources. Intergovernmental and public/private/academic partnerships will become increasingly necessary and useful cost effective approaches in the information industry. A recent analysis concluded that a multiorganizational GI development project results in a benefit: cost ratio of four to one, as compared to a two to one ratio with a single organizational approach.[31] To implement these multiorganizational resources, reference bases, data responsibilities, documentation, and exchange standards are needed and must be agreed on by interested entities.

• • •

This country has more information and technology than any other, but its usefulness cannot be maximized without an appropriate focus and organizational modernization. States are in a key role to effectuate this change. An investment in the future can be made by developing and marketing information resources to maintain the United States' strength as the world's knowledge center. Too often, states compete in economic development efforts. Instead, states should focus on GI as an opportunity and process for working together, maximizing resources and technological capabilities, and for improving our governmental effectiveness and international competitiveness. The future will be difficult and uncharted, but this field ensures opportunity and challenge for all involved.

REFERENCES

1. U.S. Congress Office of Technology Assessment. *Federal Government Information Technology: Management, Security, and Congressional Oversight*. Washington, D.C.: Government Printing Office, 1986.
2. Marchand, D.A., Williams, N.J., and Powers, G. *An Information Management Strategy for South Carolina State Government*. Columbia: University of South Carolina, Institute of Information Management, Technology and Policy, 1986.
3. Larsen, B., et al. *Land Records: The Cost to the Citizen to Maintain the Present Information Base, A Case Study of Wisconsin*. Madison: Wisconsin Department of Administration, 1978.
4. Dutton, W.H. "Eighty Thousand Information Systems: The Utilization of Computing in American Local Governments." *Computers, Environment and Urban Systems* 7 (1982): 253–60.
5. King, J.L. "Local Government Use of Information Technology: The Next Decade." *Public Administration Review* 42, No. 1 (1982): 31.
6. Department of the Environment. *Handling Geographic Information*. London, Great Britain: Her Majesty's Stationery Office, 1987.
7. Institute for Land Information. *Proceedings of International Federation of Surveyors XVIII Congress; Land Information Session*. Washington, D.C.: ILI, 1986.

8. Joint Nordic Project, Viak A/S. *Community Benefit of Digital Spatial Information.* Finland: National Board of Survey, 1987.
9. Wiggins, J.C., et al. "Computing Aspects of a Large Geographical Information System for the European Community." *International Journal of Geographical Information Systems* 1, no. 1 (1987): 77–87.
10. McLaughlin, J. "Land Information Management: A Review of Selected Concepts and Issues." *Survey Review* 28 (1986): 381–87.
11. Cook R.N. "Land Law Reform: A Modern Computerized System of Land Records." *University of Cincinnati Law Review* 38, no. 3 (1969): 385–448.
12. Marchand, Williams, and Powers, *An Information Management Strategy for South Carolina State Government.*
13. Cuciti, P.L., and Overman, E.S. *The Assessment of Investment Needs: A Review of Current Estimates and Approaches.* Denver: University of Colorado, Center for Public/Private Sector Cooperation, 1986.
14. Caron, L.M., and Stewart, D.S. *An Inventory of State Natural Resources Information Systems.* Lawrence: University of Kansas Space Technology Center, 1984.
15. Ibid.
16. Cornwell, S.B. "History and Status of State Natural Resources Systems." *Computers, Environment, and Urban Systems* 7 (1982): 253–60.
17. Ibid.
18. Caron and Stewart. *An Inventory of State Natural Resources Information Systems.*
19. Cuciti and Overman. *The Assessment of Investment Needs: A Review of Current Estimates and Approaches.*
20. State of Washington. *Report of Survey of State Mapping Advisory Committee Activities.* Olympia: Washington SMAC, 1987.
21. State of New York. *Property Ownership Mapping in the United States.* Albany: Division of Equalization and Assessment, 1987.
22. Jacobs, H.M. and Moyer, D.D. "Constructing a National, Rural Land Transfer Data Base." *Journal of Soil and Water Conservation* 41, No. 4 (1986): 231–34.
23. Marchand, Williams, and Powers, *An Information Management Strategy for South Carolina State Government,* 12.
24. Larsen, et al. *Land Records: The Cost to the Citizen to Maintain the Present Information Base, A Case Study of Wisconsin,* 23.
25. Orth, D.J. *Authorities and Organizations Involved with Geographic Names.* Reston, Virginia: U.S. Geological Survey, 1985, 85–305.
26. State of Washington, *Report of Survey of State Mapping Advisory Committee Activities.*
27. National Research Council Panel on a Multipurpose Cadastre. *Need for a Multipurpose Cadastre.* Washington, D.C.: National Academy Press, 1980.
28. King, "Local Government Use of Information Technology: The Next Decade," 25.
29. King, J.L., and Kraemer, K.L. "The Dynamics of Change in Computing Use: A Theoretical Framework." *Computers, Environment and Urban Systems* 11, no. 1/2 (1986): 5–25, 18.
30. Department of the Environment, *Handling Geographic Information,* 1.
31. Joint Nordic Project, Viak A/S. *Community Benefit of Digital Spatial Information,* 13.